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BULLETIN

OF THE

AMERICAN PHYSICAL SOCIETY

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PROGRAMME OF THE PROVIDENCE MEETING

AT

BROWN UNIVERSITY

Providence, Rhode Island

JUNE 20–21, 1941

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The American Physical Society

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BULLETIN

OF THE

AMERICAN PHYSICAL SOCIETY

PROVIDENCE MEETING, JUNE 20–21, 1941

(Eastern Daylight Saving Time)

THE 243rd regular meeting of the American Physical Society will be held at Brown University in Providence, Rhode Island, on Friday and Saturday, the 20th and 21st of June, 1941. Sessions will occur in the Metcalf Auditorium of the Chemistry Laboratory and in a lecture room of the Physics Laboratory, the first commencing at 10 on Friday morning. Daylight saving time prevails in Providence.

A **symposium** on "The Philosophy of Physics" will be held in the Metcalf Auditorium: the speakers and the titles of their papers follow:

W. F. G. SWANN (*Bartol Research Foundation*): **The Relation of Theory to Experiment in Physics.**

ENRICO FERMI (*Columbia University*): **The Place of Nuclear Physics among Physical Theories.**

HENRY MARGENAU (*Yale University*): **Metaphysical Elements in Physical Theory.**

PHILIPP FRANK (*Harvard University*): **Why do Scientists and Philosophers so often Disagree about the Merits of a New Theory?**

Ten-minute papers have been offered for presentation according to the list appended.

Hotels. The Providence-Biltmore Hotel offers single rooms at $3.50 per night, double rooms at $5.50, double rooms with twin beds at $6. Other hotels mentioned by the Local Committee are the Narragansett and the Crown. Reservations should be made as early as possible, by letter to the hotel. Members are reminded that it is the practice of hotels not to hold reservations into the evening hours, unless specifically so requested (with an indication of the presumptive hour of arrival of the guest).

The **dinner** of the Society will be held on Friday evening at 7 P.M. in the Providence-Biltmore Hotel. The price will be $1.75 per plate including tip. Please notice the request at the end of the section "Excursions." Tickets for the dinner must be bought before 2 P.M. on Friday; they will be on sale at desks in the Physics and Chemistry Laboratories.—The registration fee customary at previous June meetings is omitted on this occasion.

Restaurants available for **luncheon** will be announced at the meeting.

The University will entertain the Society at **tea** at four o'clock on Friday afternoon, in the Faunce House Art Gallery.

Excursions have been planned by the Local Committee as follows:

(a) A conducted tour through the Museum of Art of the Rhode Island School of Design;

(b) A conducted tour through the First Baptist Meeting House ("the first Baptist church in America");

(c) An inspection trip through the Brown Photographic Laboratory;

(d) An inspection of the current exhibits in the John Carter Brown Library ("which is one of the leading American treasure houses of Americana");

(e) Visits to the buildings of the University.

It is particularly requested that members wishing to join in any of these excursions should signify those of their choice in advance on the blank on page 5. Moreover the management of the Providence-Biltmore Hotel is anxious to have an estimate of the probable number of dinner guests to be expected, and there is no

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precedent of much value for making such an estimate; therefore it will be a favor if members willing to promise to come to the dinner will so indicate on the blank on page 5, which is to be sent to Professor Lindsay.

Tours of industrial laboratories are precluded for an obvious reason.

The Council will meet at 11 A.M. on Friday in Room 22, Wilson Hall, the Physics Laboratory.

As to **railroad rates** it may be a good idea to inquire of ticket agents whether there are any special rates at the time in question.

Summer Meeting at Pasadena. The summer meeting on the Pacific Coast will be held at the California Institute of Technology, Pasadena, California, on Wednesday, Thursday and Friday, June 18, 19 and 20, 1941, in affiliation with the Pacific Division of the American Association for the Advancement of Science.

General Rules Relating to Papers

By vote of the Society on December 27, 1940, no paper may be accepted for presentation at any meeting of the Society unless the title and an abstract of the paper are delivered to the office of the American Physical Society not later than the closing date stated in the printed call for that meeting.

The time allowed for the oral presentation of a contributed paper is ten minutes at most.

When two or more papers are contributed by the same member, all but one are placed on the "supplementary programme." (A paper by two or more members is credited to the one first named in its title.) For each paper on this programme the Secretary indicates a session at which it may be presented. The presiding officer at this session may call for it when the other papers are completed, may require that it be given in shortened form, or may read it by title.

Titles and abstracts of the papers to be presented are given in the following pages. Proofs of these abstracts have not been submitted to the authors. After submission of proof the abstracts will be published in an early number of *The Physical Review*.

After the Providence Meeting subsequent meetings are planned as follows:

244. November 21–22, 1941. Chicago.
245. December, 1941. Stanford University, California. Pacific Coast Meeting.
246. December 29–31, 1941. Annual Meeting. Princeton.
247. February 20–21, 1942. Detroit.

Karl K. Darrow, *Secretary*
American Physical Society
Columbia University, New York, N. Y.
June 5, 1941.

CALENDAR

Daylight Saving Time

Friday morning, June 20

10 o'clock: Metcalf Auditorium: Session A. Papers 1–10. See pages 7–8.

10 o'clock: Physics Lecture Room: Session B. Papers 11–18, and supplementary programme Paper 37, if chairman so rules. See pages 9–10 and 14.

11 o'clock: Wilson Hall: Room 22: Meeting of the Council.

Friday afternoon, June 20

2 o'clock: Metcalf Auditorium: Session C. Papers 19–27. See pages 10–12.

2 o'clock: Physics Lecture Room: Session D. Papers 28–36. See pages 12–14. To be read by title: Papers 38–42. See pages 14–15.

Friday evening, June 20

7 o'clock: Providence-Biltmore Hotel: American Physical Society Dinner.

Saturday morning, June 21

10 o'clock: Metcalf Auditorium: Session E. Symposium of invited papers on "The Philosophy of Physics." Speakers—W. F. G. Swann, Enrico Fermi, Henry Margenau and Philipp Frank. See page 15.

If you plan to attend the meeting please fill out and mail this advance registration card promptly. It will greatly facilitate the efforts of the local committee in making arrangements.

ADVANCE REGISTRATION CARD

American Physical Society

PROVIDENCE MEETING, JUNE 20–21, 1941

Please fill out at once and send to Professor R. B. Lindsay, Department of Physics, Brown University, Providence, Rhode Island.

Write directly to hotel for your room reservation.

Name ..... (Last name / First name / Initials)

I plan to go to Providence by { automobile ..... / train ..... }

I plan to take the following excursions:

(a) Museum of Art of Rhode Island School of Design .....
(b) First Baptist Meeting House .....
(c) Brown Photographic Laboratory .....
(d) John Carter Brown Library .....
(e) Buildings of the University .....

Details about time of starting and transportation will be available at the registration desk.

Please reserve ..... tickets for dinner on Friday at $1.75.

PROGRAMME

FRIDAY MORNING AT 10 O'CLOCK

Metcalf Auditorium

Session A

1. Diffusion of Thermal Neutrons. G. PLACZEK, *Cornell University.*—The transport equation for the diffusion of neutrons in an infinite medium in which scattering without velocity change, as well as capture, takes place has been solved for arbitrary distribution of isotropic sources in the cases of isotropic and of anisotropic scattering. The resulting distributions in time and space are compared with the results of the usual approximate treatment based on the diffusion equation. The relation of the solutions to the solution[1-3] of the problem of steady-state diffusion, with isotropic scattering, in a half-space bounded by a plane is discussed. In view of the fact that the scattering of thermal neutrons in paraffin seems to be rather anisotropic,[4] the application of the latter results to the diffusion of thermal neutrons in paraffin cannot be expected to yield complete agreement. This holds in particular for an attempt[2] to derive the ratio of capture and scattering cross sections.

[1] O. Halpern, E. A. Lueneburg and O. Clark, Phys. Rev. **53**, 173 (1938).
[2] E. A. Uehling and E. A. Schuchard, Phys. Rev. **58**, 611 (1940).
[3] E. A. Uehling, Phys. Rev. **59**, 136 (1941).
[4] N. Arley, Kgl. Dansk. Vid. Selsk. Medd. **16**, 1 (1938).

2. Angular Distribution of the *d-d* Neutrons. H. T. RICHARDS, *Rice Institute.*—In a recent calibration[1] of the stopping power of photographic emulsions for recoil protons, plates were placed at 0° and 90° to a heavy paraffin target 20 kev in thickness which was bombarded by 700-kev deuterons. Since the exposure conditions were identical for the plates at the two angles, the angular distribution of the neutrons from the *d-d* reaction may be inferred from the difference in number of recoil tracks on the two plates. The measured laboratory distribution $N(0°)/N(90°)=2.74$ was corrected for geometry and *n-p* scattering cross section.[1] The corrected distribution transformed to center of gravity coordinates gives $N(0°)/N(100°12')=2.70$. If the angular distribution of the neutrons is given by $N(\theta)=1+A\cos^2\theta$, then $A=1.84$ for 700-kev deuterons. At lower bombarding energies the angular distribution of the neutrons has been found[2] to be represented by the above expression with $A=0.7$ for 200-kev deuterons. Hence the angular distribution of the *d-d* neutrons is markedly dependent on the bombarding energy of the deuterons. This is similar to the result previously reported[3] for the protons from this same reaction.

[1] H. T. Richards, Phys. Rev. **59**, 796 (1941).
[2] Kempton, Browne and Maasdorp, Proc. Roy. Soc. **157**, 386 (1936).
[3] Huntoon, Ellett, Bayley and Van Allen, Phys. Rev. **59**, 97 (1940).

3. Yield of Neutrons and Beta-Rays from Li+H². W. E. BENNETT AND B. E. WATT, *Rice Institute.*—Measurements have been made on the yield of neutrons from lithium bombarded by deuterons. The targets of lithium hydroxide were less than 15 kev thick, and the neutrons were measured using a pressure electroscope of the Wulf type filled with methane. The excitation curve shows resonance peaks at 650 and at 1020-kev energy of the bombarding deuterons. The latter resonance is 80 kv broad and is more pronounced for neutrons in the forward direction than for neutrons at 90°. The yield of Li^8 from the same bombardment has been measured by coincidence counting of the high energy beta-rays. The yield curve shows the same resonance at 1020 kev as is shown by the neutrons. There is also a resonance at 750 kev, possibly the same as the broad 650-kev resonance for neutrons, but the peak is shifted to higher energy because Li^8 is produced by the emission of a low energy proton which must penetrate the potential barrier. A third resonance at 1350 kev is shown for beta-rays but not for neutrons.

4. 4.9-Mev Gamma-Ray from Li+H². T. W. BONNER AND H. T. RICHARDS, *Rice Institute.*—The gamma-rays from the bombardment of lithium by deuterons have been studied with Geiger counters. The energy was found, by measuring the range of Compton electrons in aluminum between coincidence Geiger counters, to be 4.9 ± 0.3 Mev. An absorption curve of the gamma-radiation in lead was taken to determine the ratio of intensities of the 4.9-Mev and the 440-kev radiation. The lower energy gamma-radiation is so much weaker that it was not detected. The yield of gamma-radiation as a function of bombarding energy was measured. The excitation curve was very similar to the neutron yield curve from the same bombardment. Since over 90 percent of the neutrons are from the disintegration of the Li^7 isotope, the neutron excitation curve is characteristic of Be^9 as the intermediate nucleus. Therefore the gamma-rays were not produced by the bombardment of the Li^6 isotope nor of any impurity in the target. However a similar yield curve would have been observed if the gamma-rays had been produced by inelastic scattering of the lithium neutrons in surrounding materials. This possibility was excluded by quantitative measurements.[1]

[1] Bennett, Bonner, Richards and Watt, Letter to the Editor, Phys. Rev., to be published.

5. Internal Conversion in Mercury. G. E. VALLEY,* *Harvard University.*—The radiation emitted by radioactive mercury formed by deuteron bombardment of gold will be discussed. It consists almost entirely of internal conversion

lines lying in the energy region between 50 kev and 200 kev. The most intense of these fall at 63, 75, 84, 125 and 157 kev. Of these five at least the most energetic pair accompany the 25-hour decay period which has been ascribed to Hg^{198} by R. Sherr.[1]

* National Research Fellow.
[1] R. Sherr, Private communication.

6. β-Spectra of Some Uranium Fission Products. G. L. WEIL, *Columbia University.*—The β-spectra of Kr^{88} ($T=3$ hr) and its daughter product Rb^{88} ($T=18$ min)[1] were investigated in a hydrogen-filled cloud chamber placed in a magnetic field. The radioactive krypton was extracted from a slow neutron irradiated uranyl nitrate solution and introduced into a thin-(12.4 mg/cm²) windowed cell located inside the cloud chamber. The electron spectrum of the composite source (Kr+Rb) shows a maximum at $H\rho$ 3500 and an end point at $H\rho$ 18,000. The spectrum clearly indicates the presence of at least two energy groups. Rb^{88} alone was obtained by collecting recoils from Kr^{88} disintegrations on thin aluminum foil (3.5 mg/cm²). Its spectrum shows a maximum at $H\rho$ 6000 and an end point at $H\rho$ 18,500 (5.06±0.10 Mev). A straight line can be fitted to a Fermi plot[2] over the energy range 2.5 Mev to the end point. By subtraction of the rubidium spectrum from the composite (Kr+Rb) spectrum an end point of $H\rho$ 9200 (2.3 Mev) is obtained for Kr^{88}.

[1] G. N. Glasoe and J. Steigman, Phys. Rev. **58**, 1 (1940).
[2] F. N. D. Kurie, J. R. Richardson and H. C. Paxton, Phys. Rev. **49**, 368 (1936).

7. Nuclear Spin and Magnetic Moment of In^{113}. T. C. HARDY,* *The City College of New York,* AND S. MILLMAN,* *Queens College.*—The radiofrequency spectrum of the ground state of the indium atom has been studied in fields ranging from 3000 to 7000 gauss. Lines characterized by the transitions $\Delta F=0$, $\Delta m=\pm 1$, have been observed for In^{113} as well as for In^{115}. The ratio of the depths of the resonance minima of a given transition observed in the two isotopes is in agreement with the known abundance ratio. The experiments give conclusive evidence that the spin of In^{113} is 9/2, the same as that of In^{115}. The ratio of the magnetic moments $\mu 113/\mu 115$, which is the same as the ratio of the hyperfine separations of the ground states of the two isotopes, is 0.998. The sign of the moment of In^{113} is positive, the same as that of In^{115}.

* Research done in laboratories of Columbia University.

8. The Nuclear Spin and Magnetic Moment of K^{40}. JERROLD R. ZACHARIAS,* *Hunter College.*—The molecular beam magnetic resonance method has been employed to observe the nuclear spin and the separation $\Delta\nu$ of the hyperfine-structure doublet of K^{40}. The apparatus and procedures used were different from those previously used by Kusch, Millman and Rabi[1] in their experiments with other alkali atoms because of the small natural abundance of K^{40} and because both the nuclear spin and the value of $\Delta\nu$ were previously unknown. The nuclear spin of K^{40} is shown to be 4 and the value of $\Delta\nu$ is 1285.65±0.1 megacycles per second. The doublet is inverted. By comparison with the known nuclear magnetic moment and $\Delta\nu$ of K^{39}, the nuclear moment of K^{40} is shown to be -1.290 nuclear magnetons.

* Research done in laboratories of Columbia University.
[1] Kusch, Millman and Rabi, Phys. Rev. **57**, 765 (1940).

9. Interaction between Nuclear Spin and Molecular Rotation. HARVEY BROOKS, *Harvard University.*—The Hamiltonian for a diatomic molecule in a magnetic field contains coupling terms $-\mu H'\mathbf{I}\cdot\mathbf{J}$ for each nucleus where μ is the nuclear magnetic moment, $\mathbf{I}$ the nuclear spin operator, and $\mathbf{J}$ the angular momentum operator for molecular rotation. I have developed the quantum-mechanical formula for the constant H', which is

$$H'=\frac{Ze}{McR^3}\left[1-\frac{R}{Zm}\frac{\langle L_1^2/r_1^3\rangle_{Av}}{\bar{E}}\right],$$

where M is the reduced mass, Z the nuclear charge, R the internuclear distance, and $\bar{E}$ a "centroid" frequency. In the expression $\langle L_1^2/r_1^3\rangle_{Av}$ L_1^2 is the electronic angular momentum about the nucleus rather than the molecular midpoint. I have calculated $\langle L_1^2/r_1^3\rangle_{Av}$ for H_2 with Nordsieck's wave function. $\bar{E}$ is estimated by comparison of "upstairs" and "downstairs" centroids as described previously.[1] The theoretical field H' is 24.6 gauss as compared with the observed 27.2. For HD and D_2 the experimental H' is proportional to M^{-1} as predicted by the theory.

[1] H. Brooks, Bull. Am. Phys. Soc., Washington Meeting, May 1, 1941, No. 57.

10. Angular Distribution of γ-Quanta Emitted Following β-Decay. DONALD R. HAMILTON,* *Harvard University.*—A nucleus left excited after β-decay emits one γ-quantum in the simplest case. One may investigate theoretically the probability, $W(\theta)$, that the direction of emission of this quantum will make an angle θ with that of the β-ray. The procedure is analogous to that used when a γ- instead of a β-ray is emitted in the first transition.[1] $W(\theta)$ depends on the γ-ray multipolarity, the angular momenta of the three nuclear levels involved, and the β-interaction. We have considered the Fermi and K–U interactions, using the plane wave electron approximation (light nuclei, high energies). $W(\theta)$ is uniform (independent of θ) for allowed transitions but non-uniform for "forbidden" transitions which are made possible by retardation of the electron waves across the nucleus. The non-uniformity is much greater for the Fermi interaction than for the K–U and is greatest, in either case, when the successive angular momenta are 0, 1, 0. Here (dipole γ-ray) $W(\theta)=1-9/13\cos^2\theta$ (Fermi) or $1-1/11\cos^2\theta$ (K–U). In general, the non-uniformity is increased if only the higher energy electrons are considered.

* Society of Fellows.
[1] D. R. Hamilton, Phys. Rev. **58**, 122 (1940).

FRIDAY MORNING AT 10 O'CLOCK

Physics Lecture Room

Session B

11. X-Ray Diffraction Analyses of Calcium Salts in Gall Stones. R. PEPINSKY, *University of Chicago.**—In conjunction with studies on gall stone formation carried out in the University of Chicago Clinics by Dr. D. B. Phemister and his collaborators, x-ray diffraction analyses were made of forty-five stones from thirty-two cases showing precipitates rich in calcium salts. These analyses revealed two general and distinct types of aberrant calcium metabolism, the more common resulting in precipitation of one or more of the three polymorphic forms of calcium carbonate, and the other in the deposition of an apatite-like carbonate-phosphate similar to the material of bone or teeth. In the case of the carbonate precipitates, the polymorphs—calcite, aragonite and vaterite—appeared singly, or all three together, or in the combinations calcite-aragonite or calcite-vaterite, indicating specifically-differing precipitation conditions. Vaterite was apparently stabilized by the presence of bile pigments, and was often found free or almost free of the other forms. Four cases of phosphate precipitation, in the form of very finely-divided crystals, were observed, and in each of these the bladder was packed with large stones showing increasing pigmentation from duct to fundus. The value of compound and phase identification as a key to precipitation conditions, and the identification of organic constituents by the diffraction method, will be discussed.

* Now at U. S. Rubber Company, Providence, Rhode Island.

12. Fine Structure in the Diffraction of Low Speed Electrons. H. E. FARNSWORTH AND W. E. JOHNSON, *Brown University.*—Fine structure of electron diffraction beams has been observed by one of us[1] for a wide range of angle of incidence including normal incidence. For the case of symmetrical reflection, at a particular angle of incidence, from planes parallel to the crystal surface, the structure is observed by noting the variation of reflected intensity as the incident voltage is changed. Laschkarew[2] has suggested that, for several particular voltages, reflections from other sets of planes will occur besides those from the set under consideration; and these additional reflections may occur partially at the expense of the symmetrical reflection, thus resulting in depressions at several voltages. We have carried out more detailed computations than those of Laschkarew and find that such reflections are not adequate to account for the fine structure observed. Also, the fine structure characteristics from a single crystal face in different azimuths are found to be the same.[3] This would not be expected from the considerations of Laschkarew.

[1] H. E. Farnsworth, Phys. Rev. **40**, 684 (1932); **43**, 900 (1933).
[2] W. E. Laschkarew, Trans. Faraday Soc. **31**, 1081 (1935).
[3] H. E. Farnsworth, Phys. Rev. **49**, 598 (1936).

13. Optical Filtration in Stratified Media. R. B. LINDSAY, *Brown University.*—The transmission of light at normal incidence through a stratified medium consisting of alternate plane parallel layers of two different substances is closely analogous to the transmission of elastic waves through non-homogeneous media. In the optical case the electrical and magnetic field vectors play roles corresponding to the pressure and volume current, respectively, in the acoustical case. The theory of elastic wave filtration[1] can at once be applied and leads to the characteristic function for the equivalent infinite structure

$$\cos W = \cos 2k_1 l_1 \cdot \cos 2k_2 l_2 - \tfrac{1}{2}\left(\frac{n_1}{n_2}+\frac{n_2}{n_1}\right)\sin 2k_1 l_1 \cdot \sin 2k_2 l_2,$$

where l_1 and l_2 are the layer thicknesses respectively, while n_1 and n_2 are the absolute indices of refraction of the two substances. As usual $k_1 = \omega/c_1$ and $k_2 = \omega/c_2$, where c_1 and c_2 are the light velocities in the two layers and $\omega/2\pi$ is the frequency. If the layers are composed of crown glass and air of thickness 0.008 cm and 0.001 cm, respectively, the transmission bands in the yellow part of the spectrum are approximately 6.5A wide and the attenuation bands approximately 0.75A wide. It is comparatively easy to observe the bands by passing white light through a pile of microscope cover glasses and examining it by means of a reflection grating of moderate resolving power.

[1] Cf. J. Acous. Soc. Am. **5**, 202 (1934).

14. The Absorption of Alkali Halides in the Extreme Ultraviolet. EDWIN G. SCHNEIDER, *Stevens Institute of Technology.*—Absorption measurements on thin films of alkali halides have been extended into the region between 400 and 1000A. Difficulties due to overlapping orders of spectra were avoided by using a speculum grating at normal incidence, the low reflecting power for the short wave-lengths furnishing a convenient lower limit to the spectrum. The salts were deposited on thin films of Formvar, a plastic made by the Shawinigan Products Corporation, prepared by placing a drop of a chloroform solution of the plastic on water. A number of intense narrow bands are evident. Some of these are identified as transitions from the inner shells of electrons in the atoms to discrete excited states while others are probably caused by structure in the continuous absorption region.

15. Selection Rule for Collisions of the Second Kind. J. G. WINANS, *University of Wisconsin.*—The sensitized fluorescence spectrum of tin in Hg vapor at about one-cm pressure excited by 2536 showed 3034 ($^3P_0 - {}^3P_1$) much stronger than 3009 ($^3P_1 - {}^3P_1$). The carbon arc spectrum of tin showed these lines with about equal intensity. The corresponding lines of lead 3683 ($^3P_0 - {}^3P_1$) and 3639 ($^3P_1 - {}^3P_1$) appeared with nearly equal intensity in both sensitized fluorescence and carbon arc spectra. However, sensitized fluorescence of lead at high mercury pressures

(15 to 40 cm) gave 3683 as the only lead line with appreciable intensity, and therefore much stronger than 3639. The unequal excitation of these lines may be attributed to 6^3P_0 Hg atoms since, at high pressure, Hg 6^3P_1 would be quenched by collisions with Hg atoms and at low pressure with tin by transfer of energy to those tin levels which have very low energy discrepancy. The selection rule which appears to be followed is: For change of J from 0 to 0 in Hg, a collision of the second kind is more likely if a change in J from 0 to 0 takes place in Sn or Pb. The more general rule may be ΔJ equals zero where J is the resultant angular momentum vector for the quasi-molecule formed upon impact of Hg with Sn or Pb. If excitation is from Hg_2' $^1\Sigma$ from $^1S_0$ and $^3P_0$, the same selection rule is indicated.

16. A Radiant Energy Theory of the Absorption of Primary X-Rays, Ionization and Photoelectron Emission. SAMUEL R. COOK, *Sacramento, California.*—An explanation of the absorption of primary x-rays by matter has been made, in accordance with the tenets of the radiant energy theory of primary x-rays. It has been shown that the product of the absorption of a radiant energy quantum is a high speed beta-electron, and that the liberation of the electron from a molecule produced ionization of the absorbing material. It was also shown that the high speed beta-electron, which was the direct product of the absorption of a primary x-ray, was, when liberated from the absorbing material, a photoelectron, which explained photoelectron emission. Equations for the absorption were developed and it appeared that the equation for absorption of a primary x-ray and the liberation of a beta-electron was identical with Einstein's equation for photoelectron emission.

17. Phenomena of Photophoresis and Special Application for the System Sun-Earth. LEO BANET (*Introduced by W. F. G. Swann*).—A short description of the phenomena of longitudinal photophoresis, electro-photophoresis and magneto-photophoresis (i.e. the movement of small particles in the beam of light itself and the movement of such particles under the influence of electric and magnetic fields) will be given. Considering the fact that the phenomena have not been clearly explained by mechanical or radiometer forces, an interpretation on the basis of electric and magnetic forces will be given. Some applications for the phenomena on the Sun and on the Earth will be cited where photophoretic effects are observed. The influence of the sunspot cycle on the terrestrial phenomena as well as the general influence of the radiation of the Sun on the Earth's magnetism will be described. The possibility of finding an explanation of the cause of the earth's magnetism in terms of the photophoretic influence will be discussed.

18. Photophoresis: Applications and the Question of the Existence of Unipolar Magnetism. FELIX EHRENHAFT (*Introduced by W. F. G. Swann*).—The interpretation of the phenomena of photophoresis leads to new consequences. Such are the "trembling-effect" discovered in the observation of magneto-photophoresis, the coagulation of matter under the influence of the light, the growth of some crystals toward the light, the influence of the light on Brownian movement and diffusion, etc. On the hypothesis of a unipolar magnetic "ion" it is also possible to determine from those measurements the magnitude of its magnetic charge. The question of the existence of unipolar magnetism is discussed, and the insufficiency of experimental evidence against it is indicated.

FRIDAY AFTERNOON AT 2 O'CLOCK

Metcalf Auditorium

Session C

19. Operational Details of the Bartol Electrostatic Generator. W. E. DANFORTH AND EMMETT L. HUDSPETH, *Bartol Research Foundation of the Franklin Institute.*—A vertical pressure Van de Graaff generator has been completed and is now undergoing preliminary tests. The unit is patterned after the compact x-ray generators of Trump and has been adapted for positive ion acceleration. A tank 13 feet in over-all height and 44 inches in diameter, which will withstand a pressure of 200 pounds, encloses an accelerating tube of twenty porcelain cylinders, each of which is 6½ inches I.D. and 3¼ inches in height. Fifty-two equipotential rings of 24-inch diameter surround the accelerating tube; uniform potential distribution is obtained by connecting adjacent rings through a 500-megohm IRC power resistor. The ion source assembly is supplied by a 120-v d.c. generator and a 110-v a.c. converter. Controls for the apparatus in the high potential spinning are connected by flexible shafting to textolite rods which run to a gear box and more flexible shafting at the bottom of the tube. Small lamps, connected in the separate circuits of the ion source, are focused on photoelectric cells at the lower end of the tube. Variation of the respective intensities of the lamps yields corresponding photoelectric currents. These have been suitably calibrated to give reliable readings of instruments in the high-potential spinning.

20. Consequences of the Assumption of a Single Primary Component in the Cosmic Radiation. W. F. G. SWANN, *Bartol Research Foundation of the Franklin Institute.*—The paper comprises an extension of the discussions already made by the writer of the effect of energy combined with mean life considerations in determining the degree of

asymmetry in electron emission at different altitudes. When the logarithm of the mesotron intensity is plotted against altitude, the relation is linear for low altitudes when the altitude is expressed in terms of actual distance, but it is non-linear when expressed in terms of water equivalent distance. The reverse is true at higher altitudes where linearity occurs when water equivalent distance is used. The relation of these facts to the relative parts played by mean life considerations and ionization loss is discussed. The bearing of the sea-level latitude effect in relation to the initial energy of the mesotrons and of their parents is examined.

21. On the Theory of the Photo-Effect in Semi-Conductors. V. F. WEISSKOPF AND L. W. APKER, *University of Rochester*.—The surface photo-effect in metals has so far been calculated by using Sommerfeld's assumption of completely free electrons within the metal. This assumption is justified for good conductors in which the characteristic energy bands are half-filled. In the case of semi-conductors, however, it is assumed that the energy bands are completely filled and the free electron theory is no longer adequate. The number of electrons $N(E)dE$ emitted with a given energy E by light of frequency ν is proportional to the number of electrons with an equivalent energy ϵ within the material and proportional to the transition probability P. If the electrons emitted come from states in the upper edge of a filled band, as it is in the case of a semi-conductor, we can make use of the fact that the density of states near the upper edge is known to be const. $(\epsilon_0-\epsilon)^{\frac{1}{2}}d\epsilon$ where ϵ_0 is the highest energy in the band. We further assume that the probability P is proportional to the velocity of the "hole" created by the removal of the electron, which carries away the charge, and obtain $N(E)dE=\text{const.}\ (h(\nu-\nu_{th})-E)^2dE$ where ν_{th} is the threshold frequency. This distribution should be independent of the temperature. Measurements to verify this distribution are under way in this laboratory.

22. Preparation of Tungsten Single Crystal Faces for Thermionic Emission Studies. A. A. BROWN, *Brown University* (*Introduced by H. E. Farnsworth*).—For obtaining thermionic work functions of different faces of single crystals, it is desirable to obtain smooth plane surfaces parallel to the desired set of crystallographic planes and exposing the undistorted crystalline lattice. A method of doing this is described for the (110) and (100) faces of single crystals of tungsten. An etching solution of equal parts of boiling 30 percent $K_3Fe(CN)_6$ and 10 percent NaOH exposed only (110) type faces. Using a goniometer, the lattice orientation was then determined uniquely and a thin diamond saw used to cut parallel to the desired planes. The saw marks were removed by grinding and the surface polished with dry levigated alumina on a hard surfaced lap. This left a disturbed layer which had to be removed. No chemical reagent could be found which would etch parallel to the surface without excessive pitting. A few attempts at heat treatment produced only a mosaic surface composed of randomly oriented crystallites. Satisfactory surfaces were finally obtained by partially removing the disturbed surface by electrolytic polishing with NaOH followed by heat treatment at 2600°K. It was determined by very slight chemical etching that this exposed the undistorted lattice.

23. Attenuated Superconductors. II. Pb, Sn, Cb and Ta. W. F. BRUCKSCH, JR., W. T. ZIEGLER, F. H. HORN AND DONALD H. ANDREWS, *The Johns Hopkins University*.—Measurements previously reported[1] on films have been extended by using films of Pb from 0.02μ to 1μ thick. The same technique was also applied to fine wires of Pb, Sn, Cb and Ta with diameters ranging from 26μ to 260μ. Variation of resistance with temperature was studied in the neighborhood of the superconducting transition point, with magnetic fields ranging from zero to ninety oersteds and with currents from 10^{-5} to 0.3 amp. All the samples of lead studied including evaporated films, drawn wires, and capillary-moulded wires had transition temperatures identical to within 0.05°, the probable experimental error. The width of the transition zone varied from 0.02° for a film 0.6μ thick to 0.08° for a film 0.02μ thick. Critical current values increased and approached the bulk metal value as thickness increased. In contrast with Sn and Pb, the hard metals Cb and Ta showed a depression of the transition temperature as the wire diameter was reduced. Cb wire, 25μ diam., had a transition at about 7°K and showed a residual resistance of 1 percent below this temperature. Ta wire, 25μ diam., failed to become superconducting even at 3.2°K. An x-ray study showed it to be polycrystalline.

[1] Phys. Rev. **59**, 688 (1941).

24. Young's Modulus of NaCl Near the Melting Point. LLOYD HUNTER, *Carnegie Institute of Technology*, AND SIDNEY SIEGEL, *Westinghouse Research Laboratories*.—Measurements of Young's modulus were made on several different NaCl crystals cut in {100} and {110} orientations. The temperature range covered was 290°K to 1077°K, the melting point of NaCl. The method used was a piezoelectric oscillator method. The oscillator consisted of a quartz crystal driver, a long fused silica rod which extended into the high temperature furnace, and the NaCl specimen. This arrangement made it possible to keep the quartz crystal near room temperature and at the same time drive a specimen at high temperature, thus obviating any difficulties due to the quartz crystallographic change at 849°K. It was found that for the {100} orientation the Young's modulus decreases from 4.440×10^{11} dynes/cm^2 at 290°K to 1.527×10^{11} dynes/cm^2 at the melting point. The Young's modulus of the {110} orientation does not change as rapidly, decreasing from 3.490×10^{11} dynes/cm^2 at 290°K to 2.062×10^{11} dynes/cm^2 at the melting point. The Young's modulus is the same for both orientations at 653°K, thus showing that NaCl is elastically isotropic at this temperature.

25. Theory of Cathode Sputtering in Low Voltage Glow Discharges. C. H. TOWNES, *Bell Telephone Laboratories*.—Cathode sputtering has been shown to involve the release of atomic material from the cathode by an impinging positive ion and the subsequent diffusion of this material

to surfaces surrounding the cathode. To determine the amount of sputtering in a glow discharge three functions must be known: the number of ions of a given energy striking the cathode, the amount of material released from the cathode by each ion, and the fraction of material released from the cathode which diffuses away. Estimates are made of these, and an expression is obtained giving the dependence of the total rate of sputtering on the geometry of the discharge, pressure, cathode fall, current, and constants of the gas and cathode surface. It is most accurate for very low voltage, high pressure discharges. Comparisons with data will be given.

26. Visualizing Airflow. ERWIN J. SAXL, *Providence, Rhode Island.*—Bullets passing through air at great velocity are known to set up compression and decompression waves that can be made visible under certain conditions of spark photography. Inversely, air passing objects at great velocities produces upon them distinct disturbances that possibly are at the root of the vortices, and discontinuities that peal off subsequently from such surfaces and greatly reduce the potential speed of fast aircraft as observed on a larger scale in wind-tunnel experiments. A new technique was developed by the writer whereby the origin of such vortices can be made visible directly. Wave phenomena of a recurring geometrical pattern were recorded. The method lends itself to the investigation of surfaces and objects of every description. Photographs of air moving in the neighborhood of sound velocity relative to objects have been made, particularly of air escaping orifices at approximately sonic speed. A peculiar wave pattern is recorded within that air stream. The speed of the air was calculated from the pressure of the gases before leaving the throat. The theoretical fundamentals are discussed that underlie the phenomena recorded and suggestions are made as to the utilization of the facts observed with particular reference to today's high speed airplanes, internal combustion engines and other instances where gases travel at high relative speeds.

27. Acoustic Filtration in Parallel Conduit Structures. L. W. LABAW, *Brown University (Introduced by R. B. Lindsay).*—The acoustical structure consisting of parallel conduits (Quincke-Herschel tubes) combined in series by means of single conduit connectors has been studied theoretically, and found to be a band pass acoustic filter.[1] By varying the dimensions of the conduits, nearly any frequency region up to 10,000 cycles may be attenuated. The energy transmission between the attenuation bands depends on the number of sections and the type of ending. Measurements of the transmitted power were made by recording on an oscillograph the amplified voltage from a small Rochelle salt crystal sound cell which was used as a detector and constructed to fit in the connecting conduit with its length along the tube axis and its width along the tube diameter. The number of experimental peaks in the transmission regions, and the position of the attenuation bands agree with the predictions of the theory. The values of the curve minima in the transmission bands are in excellent agreement up to 5000 cycles. The change of phase over the filter was also measured and found to correspond closely to the theory.

[1] L. W. Labaw, J. Acous. Soc. Am. **12**, 232 (1940).

FRIDAY AFTERNOON AT 2 O'CLOCK

Physics Lecture Room

Session D

28. Molar Refraction of Carbon Dioxide as a Function of Density. F. B. OLESON AND C. E. BENNETT, *University of Maine.*—Recent measurements on carbon dioxide have not only confirmed the results of preliminary work recently reported by the senior author[1] but have extended the density values to 0.0448 gram per cc. Whereas Keyes and Oncley[2] report an increase in molar polarization with density at large density values, the present findings, based upon precise optical measurements at lower densities, indicate a definite decrease of this quantity when the density values are computed by the Keyes equation of state. It is noted, however, that the results are changed somewhat by the use of the Beattie-Bridgeman equation of state, but not enough to conclude that the molar refraction at zero frequency increases with density. The question is thus raised whether or not molar refraction at zero frequency is the same as molar polarization of carbon dioxide. The best value of molar refraction at zero frequency (referred to by some authors as the L–L function) found by displacement interferometry is between 6.55 and 6.65 when extrapolated to zero density.

[1] C. E. Bennett, Phys. Rev. **58**, 263 (1940).
[2] F. G. Keyes and J. L. Oncley, Chem. Rev. **19**, 3, 195 (1936).

29. Vapor Pressure Determination of HTO and DTO. W. F. LIBBY AND R. CORNOG, *University of California.*—The vapor pressure of HTO in H_2O and DTO in D_2O has been measured as a function of temperature in the range of 25°C to the boiling point under one atmosphere. Because of the sensitivity of the radioactive method employed, it has been possible to check the accuracy of Henry's law at dilutions of one part in ten million. It is also possible, assuming a perfect solution, to compute that the boiling point of pure HTO under a pressure of one atmosphere is less than that of H_2O.

30. Turbulent Flow of Argon in a Hot-Wire Clusius and Dickel Column. RALPH SIMON, *Yale University.*—The "hot wall" of a 22-mm diameter glass column two meters long is a 20-mil tungsten wire. Following the method of Onsager and Watson,[1] the pressure at which lamellar flow breaks up into turbulence is determined at various wire temperatures from 400° to 1700°K. The curve of critical pressure *versus* temperature has a minimum at 650°±50°K. From this fact it is possible to estimate the value of the exponent in the viscosity law $\eta = cT^n$ in fair agreement with viscosity measurements. The Reynolds' number for the hot-wire type of convective flow is found to be much less than that for pressure flow through cylindrical tubes. A preliminary investigation of this type should prove extremely valuable in the design of a thermal diffusion apparatus because the onset of turbulence (the avoidance of which is essential for efficient operation) sets an upper limit to the usable value of Kc/Kd, the ratio of remixing by convection and by diffusion. It is planned to construct an apparatus for the concentration of the A^{36} isotope.

[1] L. Onsager and W. W. Watson, Phys. Rev. **56**, 474 (1939).

31. Correlations in Dielectric Data. ROBERT H. COLE, *Harvard University.*—It is well known that it is possible to calculate the transient current in a dielectric as a function of time after application of a constant potential difference if the frequency dependence of the complex dielectric constant is known, and vice versa. The fact that either the real or the imaginary part of the complex dielectric constant may be used for this calculation suggests that either one of these quantities is determined if the complete frequency dependence of the other is known. Integral equations expressing this correlation have been given by Kramers for the case of optical dispersion.[1] It will be shown that these relations may be derived (a) from the expressions for the transient current by use of Fourier transforms, or (b) as a special case of the Hilbert transforms. A knowledge of either the real or imaginary parts of the complex dielectric constant *versus* frequency or the transient current *versus* time thus specifies completely the dielectric properties at a given temperature of a substance for which the superposition principle is valid. Possible applications of these relations and their bearing on some previous attempts to correlate dielectric data will be discussed.

[1] H. A. Kramers, Atti Congr. dei Fisici, Como (1927), p. 545.

32. A Derivation of the Thermodynamic Equations for the Heats of Reaction of Saturated Weston and Clark Standard Cells. F. G. BRICKWEDDE AND L. H. BRICKWEDDE, *National Bureau of Standards.*—Saturated cells involving the formation of *hydrated* salts are either neglected or incorrectly treated in even the most recent texts on thermodynamics. The Gibbs-Helmholtz equation relating the heat of the cell reaction to the free energy changes is not directly applicable to the electromotive force of cells in which the concentration of a solution entering the cell reaction changes with temperature. Only in Jellinek's *Lehrbuch der physikalischen Chemie* (1930) have we found a derivation of the equation $Q/2\mathbf{F} = E - T(dE/dT)$ for such saturated cells, where Q is the heat of the complete cell reaction and E is the e.m.f. of the saturated cell. A simpler and more satisfactory derivation of this equation will be given. Equations are obtained relating the e.m.f. of a *saturated* cell with the heat changes of the various parts of the cell reaction. For example, for the reaction Cd (2-phase amalgam) $+ Hg_2SO_4(c) = 2Hg(l) + CdSO_4$ (dissolved in sat. soln.) the equation is

$$Q' = 2\mathbf{F}\left[E - T\left(\frac{dE}{dT}\right)_{\text{sat.}} + T\left(\frac{\partial E}{\partial m}\right)_T \left(\frac{dm}{dT}\right)_{\text{sat.}} - T\left(\frac{\partial E}{\partial p}\right)_T \left(\frac{dp}{dT}\right)_{\text{sat.}}\right],$$

where m and p are the concentrations of the aqueous solution and solid amalgam, respectively.

33. Optimum Design of Physical Apparatus. R. C. SPENCER, *University of Nebraska.*—A distortionless apparatus would be one for which the output function $G_1(x)$, after correction for a possible shift h in the origin, is proportional to the input function $G_0(x)$. Thus, $G_0(x) = e^{hD}G_1(x)$, where the relative impedance e^{hD} is the Heaviside shift operator. The optimum design for low values of hD is obtained by expanding the operator for the apparatus into a power series $\Sigma a'_n D^n$ and then equating the first few coefficients to those of e^{hD}. There are four equivalent[1] conditions. (1) $a'_n = a'^n_1/n!$ (2) Each reduced coefficient is zero. (3) The moments μ'_n of the response of the apparatus to a unit impulse are given by $\mu'_n = \mu'^n_1$. (4) Each reduced moment is zero. Only underdamped systems satisfy these conditions so that a static system whose response is essentially positive must be coupled to an underdamped dynamic system. This method satisfies the two conditions of constant amplitude response and linear phase response necessary in television. Although ideal for low frequencies, the method introduces resonance peaks at the higher frequencies. The theory is illustrated by examples from spectroscopy, statistics and television.

[1] R. C. Spencer, Phys. Rev. **55**, 239A (1939).

34. The Principle of the Unobservable. H. M. DADOURIAN, *Trinity College.*—After analyzing the concept of the unobservable, Herbert Dingle has reached the conclusion that we must either presume omniscience, or abandon our belief in the external world, if we accept the principle: *That which is observable is not significant.* As the first alternative is untenable, Dingle has faced us with the dilemma of either accepting a form of solipsism or abandoning a principle which has proved to be of great value. Dingle's dilemma is due to his tacit assumption that the principle states a logical proposition. The dilemma disappears if the principle of the unobservable is taken to be what it really is—an heuristic principle, a useful and convenient rule of action for investigators.

35. Physical Theory and a Monistic Conception of the Universe. ENOS E. WITMER, *University of Pennsylvania.*—In this paper an attempt is made to interpret the theory of relativity and quantum mechanics from a more general

point of view, into which the facts of biology and psychology can be fitted in a satisfactory manner.

36. Physics as "Useful Fiction." G. A. FINK, *C. K. Williams and Co.*—Some of the sources of the philosophical theory to be presented, and some of its resemblances to others, are noted. Definitions of science, physics, philosophy, fiction and usefulness are given. The science of physics, considered as a human activity which has evolved from crude beginnings, is discussed from an esthetic and psychological point of view. The characteristics desirable for a physical theory—agreement of its predictions with experiment, logical coherence, simplicity and use of familiar space-time concepts with a minimum of modification—are discussed, and explained by the "useful fiction" theory. The fictional nature of all physical concepts is emphasized and illustrated, using "force" as the chief example. The spirit of the present theory is well illustrated by the following excerpt from the chapter on "The Art of Thinking" in Havelock Ellis' *The Dance of Life:* "thinking we may regard as fiction that helps us to live." And thinking is the most essential part of the activity we call science.

SUPPLEMENTARY PROGRAM

37. On a Modification of Planck's Quantum Theory with Special Reference to an Explanation of His Oscillators.* SAMUEL R. COOK, *Sacramento, California.*—The paper consists of a statement of Planck's quantum theory in the light of the tenets of the radiant energy theory of the genesis and absorption of primary x-rays.

* To be called for after Paper No. 18, Session B.

Papers to be Read by Title

38. Velocity of Sound in Gases at Temperatures Below the Ice Point. THOMAS H. QUIGLEY, *Holy Cross College.**—The fixed path acoustic interferometer possesses distinct advantages for work at low temperatures, such as absence of moving parts with the avoidance of leaks and contaminations of material, and the elimination of the necessity of piston rods or guides for a moving reflector. The interferometer unit consists of a ring of fused quartz with optically plane parallel faces, separating a plane fused quartz reflector and a piezoelectric quartz X cut plate with condensed gold film electrodes. This, with thermocouples, is assembled inside a copper cylinder which is supported at the bottom of a cryostat. Temperature equilibrium is maintained by balancing cooling by evaporation of liquid nitrogen and heating produced electrically in a Nichrome wire wound around the copper cylinder. Temperature is varied until a value for resonance is determined with precision. Sound velocities for 17 temperatures for air and for 12 temperatures for methane between 90°K and the ice point have been determined. These are of great self-consistency, but for each gas lead to a slightly smaller value of sound velocity at 273°.1C than that commonly accepted; for air, 330.6; for methane, 427.2 m/sec. A detailed analysis of the results will be published.

* The work here reported was done in the Laboratory of Physics of the Johns Hopkins University.

39. The Neutrino Concept. ALEXANDER W. STERN, *Brooklyn, New York.*—The evolution of the neutrino is traced from its conception by Pauli in 1931 to its recent application in the theory of stellar explosions.[1] While originally the neutrino was evoked to save the conservation laws in the beta-disintegration process, it is now called in to rationalize the hypothesis[1] of the *disappearance* of energy from exploding stars. With regard to these stellar bodies there is no conservation of energy—in fact, the star ultimately "dies" (astrophysically) from lack of energy conservation. But the nonconservation of energy is here achieved by purely conventional and accepted means—the intervention of the neutrino to "kidnap" the energy from the star. Even if the neutrino were found to exist, a process such as that envisaged by Gamow and Schoenberg would mean a violation of the conservation laws as far as the stellar bodies in question are concerned. It is interesting to note that heretofore the neutrino appeared only in a secondary role, as a "by-product" of beta-disintegration, and its emission had no physical consequence. Here its role is of primary importance and it is one of the contributing causes of the phenomenon investigated.

[1] G. Gamow and M. Schoenberg, Phys. Rev. **59**, 539 (1941).

40. Magnetic Rotatory Power of Crystalline Nickel Sulfate in the Ultraviolet Region. J. J. O'CONNOR, C. BECK, AND N. UNDERWOOD, *Vanderbilt University.*—Previous measurements of the magnetic rotatory power of crystalline α-$NiSO_4 \cdot 6H_2O$ in the visible region of the spectrum[1] and at one point in the ultraviolet[2] have been extended into the ultraviolet as far as the 2537A line of the mercury spectrum. An unsymmetrical anomaly has been found at the strong 3850A absorption band. The constants in the equation for the magnetic rotatory dispersion have been evaluated so that Verdet constants calculated from the equation agree with the experimental values throughout the visible and ultraviolet except within the 3850A absorption band. The equation is

$$\alpha = \frac{(n^2+2)^2}{9n} \frac{0.00509\lambda^2}{(\lambda^2-0.123^2)^2},$$

α is in minutes per oersted-cm, n is index of refraction and λ is in microns.

41. Scattering of Protons from 200 to 300 kev. H. MACK THAXTON, *The Agricultural and Technical College, Greensboro, North Carolina.*—G. L. Ragan, W. R. Kanne and R. F. Taschek[1] have observed the scattering of protons in hydrogen from 200 to 300 kev. Theoretical calculations

have been made for comparison with these experiments at 10-kev intervals in this energy region for potentials, Gauss[2] error ($A \exp[-\alpha r^2]$); meson[3] ($Ce^{-r/a}/r/a$); exponential[4] ($Be^{-2r/b}$); Morse[5] $D(e^{-4r/a}-2e^{-2r/a})$; and square well[2] with depth 10.5 Mev. Phase shifts have been calculated for each energy and are, for example, 8.82°; 8.67°; 9.11°; 9.02°; 8.83°; respectively, for the potentials above and the energy 250 kev. The Mott ratios are calculated for all angles from 15° to 45° and graphs of these ratios and quantities easily comparable with experiment are given as functions of angle and energy. In addition, tabulated values of all mathematical quantities necessary for direct comparison with the experimental data are given. The presence of the phase shift K_1 has been investigated and is negligible for all potentials at 300 kev.

[1] K. S. Cole and R. F. Baker, Phys. Rev. **59**, 685A (1941).
[2] G. Breit, H. M. Thaxton and L. E. Eisenbud, Phys. Rev. **55**, 1018 (1939).
[3] L. E. Hoisington, S. S. Share and G. Breit, Phys. Rev. **56**, 884 (1939).
[4] W. Rarita and R. D. Present, Phys. Rev. **51**, 793 (1937).
[5] H. M. Thaxton and D. M. Monroe, Phys. Rev. **57**, 246 (1940).

42. Total Atomic Scattering Cross Sections for Fast Electrons. L. I. SCHIFF, *University of Pennsylvania.*—Marton[1] has recently suggested that the thicknesses of electron microscope objects can be determined by measuring the transmission of the electron beam through them. To correlate transmission and thickness it is necessary to know the scattering cross sections of the atoms involved. Calculation shows that the inelastic (small energy loss) and elastic scattering are of comparable importance, and that the angular aperture of the electron microscope is so small that total cross sections can be used to calculate the diminution of intensity of the electron beam. Results have been obtained for a large number of atoms and ions using Hartree wave functions and the Thomas-Fermi model for elastic scattering, and Slater wave functions for the inelastic scattering. These will be published soon, together with a discussion of the related experiments, in collaboration with L. Marton in the *Journal of Applied Physics.*

[1] L. Marton, Bull. Am. Phys. Soc., Washington Meeting, May 1, 1941, No. 77.

SATURDAY MORNING AT 10:00 O'CLOCK

Metcalf Auditorium

Session E

Symposium

of

Invited Papers

on

The Philosophy of Physics

I. The Relation of Theory to Experiment in Physics. W. F. G. SWANN, *Bartol Research Foundation of the Franklin Institute.*

II. The Place of Nuclear Physics Among Physical Theories. ENRICO FERMI, *Columbia University.*

III. Metaphysical Elements in Physical Theory. HENRY MARGENAU, *Yale University.*

IV. Why do Scientists and Philosophers so often Disagree About the Merits of a New Theory? PHILIPP FRANK, *Harvard University.*

Author Index to Abstracts of Papers Presented at the Providence Meeting

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